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ANOTHER METHOD OF GENERATING GLINT.(U)

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RFSS

(6) ANOTHER METHOD OF GENERATING GLINT

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ANOTHER METHOD OF GENERATING GLINT

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Summary

The baseline method of computing angle glint offsets for the Distributed Sources Generation System is based on the concept of a glint centroid. In this memo, we derive an alternate method that is simpler to implement and somewhat more general.

Introduction

Let us assume the one-dimensional geometry ~~in Figure 1~~ where the monopulse receiver is sensitive to only the azimuth angle. We define θ_o as the angle from the boresight axis to a reference point on the extended target (the c.g., for example), and α_i as the angle of the ith scatterer from the reference point. If we are in the linear region of the monopulse system, the complex signal received on the sum channel is proportional to

$$V_\Sigma = \sum_i V_i \tag{1}$$

where V_i is the complex reflection coefficient of the ith scatterer.

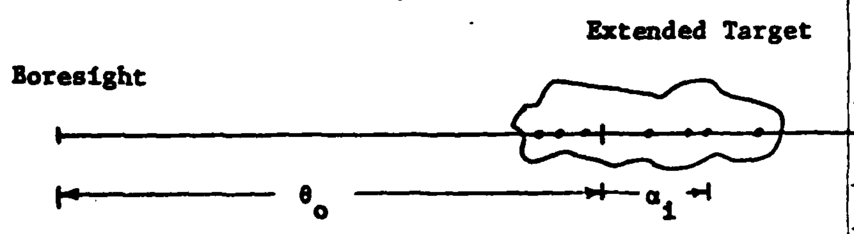

Figure 1. Geometry for Glint Centroid Method.

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For the difference channel,

$$V_\Delta = k \sum_i (\theta_o + \alpha_i) V_i \qquad (2)$$

where k is the constant of proportionality. An unbiased estimate of angle (for a point target) is given by

$$\hat{\theta} = \frac{1}{k} \mathrm{Re}\left\{\frac{V_\Delta}{V_\Sigma}\right\} \qquad (3)$$

which for the signals in (1) and (2) is

$$\hat{\theta} = \theta_o + \mathrm{Re}\left\{\frac{\sum_i \alpha_i V_i}{\sum_i V_i}\right\} \qquad (4)$$

We define the second term as the glint centroid, which is written as

$$\alpha_o = \mathrm{Re}\left\{\frac{\sum_i \alpha_i V_i}{\sum_i V_i}\right\} \qquad (5)$$

Note that for a single scatterer, the measured angle is identical to the angle of the scatterer (in a noise-free environment).

When we use the glint centroid in (5) to simulate the apparent location of the phase center, we are assuming an operation that is performed in the receiver, namely the Re{ } operation. It would be desirable to utilize a method of simulating glint that does not require *a priori* knowledge of how the receiver measures angle. In the next two sections we will discuss methods that were derived by one of the authors (Lank).

The "Two-Horn" Method

The RFSS is capable of radiating from discrete horns on the array. Let us refer to Figure 2 where points A and B designate two of these horns. The reference angle θ_o is now measured to the median point of the two horns, not

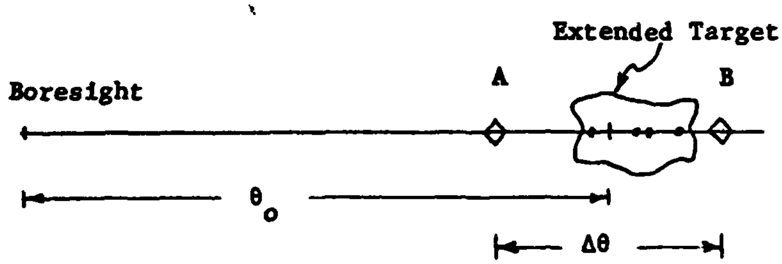

Figure 2. Geometry for "Two-Horn" Method.

the target c.g. as before. Let the horns be separated by $\Delta\theta$, and we will radiate the complex signals U_A and U_B from the two horns. Upon receive, the signals in the two monopulse channels will be proportional to

$$V_\Sigma = U_A + U_B \tag{6}$$

and

$$\begin{aligned} V_\Delta &= k(\theta_o - \Delta\theta/2)U_A + k(\theta_o + \Delta\theta/2)U_B \\ &= k\theta_o(U_A + U_B) - (k\Delta\theta/2)(U_B - U_A) \end{aligned} \tag{7}$$

Now we can set (6) and (7) equal to (1) and (2), respectively, and solve for U_A and U_B as

$$U_A = \frac{1}{2} S_o - \frac{1}{\Delta\theta} S_1 \tag{8}$$

$$U_B = \frac{1}{2} S_o + \frac{1}{\Delta\theta} S_1 \tag{9}$$

where

$$S_o = \sum_i V_i \tag{10}$$

$$S_1 = \sum_i \alpha_i V_i \tag{11}$$

Note that the operation in (3) yields

$$\hat{\theta} = \theta_o + \mathrm{Re}\left\{\frac{\sum_i \alpha_i v_i}{\sum_i v_i}\right\} \tag{12}$$

which is equivalent to (5).

Equations (8) through (11) constitute the algorithm in one dimension. It is actually simpler to implement than the one based on the glint centroid. In the next section we will extend the method to two dimensions.

The "Three-Horn" Method

The RFSS array is based on a triad of horns positioned on an equilateral triangle as shown in Figure 3. Signals U_A, U_B, and U_C are radiated from the three horns, and line OA is at an angle ϕ from the x-axis. Each horn is at a

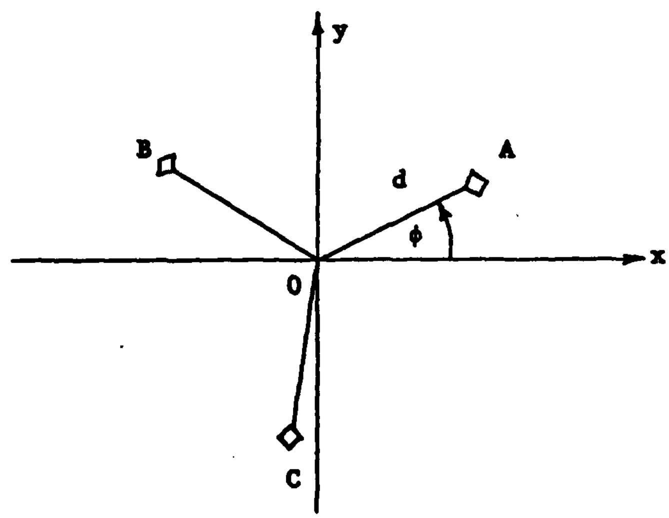

Figure 3. Geometry of "Three-Horn" Method.

distance d from the centroid of the equilateral triangle formed by the three horns. The derivation for the three signals is straightforward, but we will skip over it here and just give the result, which is

$$
\left.\begin{aligned}
U_A &= \frac{1}{3} S_{00} + \frac{2}{3d} S_{10} \cos\phi + \frac{2}{3d} S_{01} \sin\phi \\
U_B &= \frac{1}{3} S_{00} + \frac{2}{3d} S_{10} \cos(\phi+120°) + \frac{2}{3d} S_{01} \sin(\phi+120°) \\
U_C &= \frac{1}{3} S_{00} + \frac{2}{3d} S_{10} \cos(\phi+240°) + \frac{2}{3d} S_{01} \sin(\phi+240°)
\end{aligned}\right\} \tag{13}
$$

where

$$
\left.\begin{aligned}
S_{00} &= \sum_i V_i \\
S_{10} &= \sum_i \alpha_{xi} V_i \\
S_{01} &= \sum_i \alpha_{yi} V_i
\end{aligned}\right\} \tag{14}
$$

and $(\alpha_{xi},\alpha_{yi})$ is the angular coordinate of the ith scatterer in the x-y plane, referenced to the centorid of the three horns. We can interpret the sin/cos weighting in (13) as the projection of the three angles onto the x and y axes.

The above algorithm is again simpler to implement than the one based on the glint centroid. Note that the sin/cos operations will be computed only once per update; moreover, θ will generally be either 30° or 90° so that there will be only two options and the sin/cos weights can be precomputed and stored.